Fukushima Daiichi Power Plant Disaster:

How many people were affected?

2015 Report

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INTRODUCTION

Japan experienced, and the world witnessed, a devastating triple disaster four years ago that began on March 11, 2011. The 9.0 magnitude earthquake and the resulting tsunami created an unfortunate sequence of events that led to the Fukushima Daiichi Nuclear Power Plant disaster. The nuclear accident occurred after the back-to-back natural events that rocked the eastern shore of Japan; first, a 9.0 magnitude earthquake with an epicenter about eighty miles offshore, followed by a tsunami that created waves up to 50 feet in height. These two natural disasters cut off power and flooded critical areas in the power plant and initiated a sequence of events that eventually resulted in reactor meltdowns.

Both the Chernobyl and the Fukushima nuclear power plant disasters were categorized as level 7 in the International Nuclear and Radiological Event Scale (INES). However, the Chernobyl disaster released greater amounts of radiation into the atmosphere than the Fukushima accident and the plume spread across Europe, while the release of radiation from the Fukushima nuclear plant was mostly concentrated in Japan and over the Pacific Ocean. Based on calculations by Tokyo Electric Power Company (TEPCO), the total atmospheric release of radioactive material (iodine-131, cesium-134, cesium-137, and noble gases) from the Fukushima disaster was estimated as less than 15% of the total radiation emitted from the Chernobyl disaster (1). However, Greenpeace International has reported estimates for the total atmospheric release from the Fukushima disaster that range from 10% to 40% of the Chernobyl disaster release (2). The Fukushima disaster is estimated to have released amounts of iodine-131 and cesium-137 to the atmosphere that were approximately 10% and 20%, respectively, of the amounts released by the Chernobyl disaster(3). It is estimated that about 80% of released radiation from the Fukushima accident was deposited in the ocean and the remaining 20% was mostly dispersed over the Fukushima prefecture within a 50-km radius to the northwest of the power plant (1). While estimated cancer risks to humans from the radiation released over the Pacific Ocean are small, trace amounts of radiation have now reached North America, including parts of the northern West Coast of the United States (4-7).

Reports on the Fukushima disaster timeline indicate that nine months following the earthquake and tsunami, radiation was still being released from the reactors as uncooled fuel rods reacted with air, explosions occurred within the plant, and water containing radioactive material leaked from the plant (8, 9). The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) reported that radioactive material was still being released into the ocean as late as May 2013 (3). Detailed accounts of the events and failures leading to the releases have been published by experts from various groups including the Union of Concerned Scientists, the International Atomic Energy Agency (IAEA), the Investigation Committee on the Accident at Fukushima Power Stations of Tokyo Electric Power Company, Greenpeace, UNSCEAR and the US National Academy of Sciences (NAS), among others (1-3, 8, 10, 11).

As with the Chernobyl disaster, long-term health consequences other than cancer, such as psychological consequences, are anticipated. The consequences of the stress from being evacuated and displaced are of concern, as illness and death due to fatigue and stress after the accident have already been reported (12, 13).

Many reports have been compiled in the four years since the accident and experts have weighed in on lessons learned, the need for higher nuclear power safety standards, the advantages and disadvantages of nuclear power, and the costs and true damages and losses from the accident. At the time of the Fukushima accident, the amount of information collected and analyzed from the Chernobyl disaster in 1986 gave the community a glimpse of the possible implications of a disaster of this magnitude. However, it will take years to fully understand how the initial accident, displacement and continued hardships of the people in Japan will affect the quality of life of survivors and future generations.

The aim of this report is to compile information that will help to understand as fully as possible the impact of the disaster, more specifically, the number of negatively affected individuals in Japan and elsewhere due to the Fukushima nuclear power plant disaster. For this report, we define “negatively affected individuals” as those who were exposed to radiation or other stressors as a result of the disaster, and are consequently at potential risk from short-term and long-term consequences of these exposures. Within the umbrella of those negatively affected, we examine the extent of exposures of different groups, particularly those considered to have been exposed to higher doses of radiation as well as those who had lower exposures, including those living in areas where foodstuff, water, and/or vegetation have proven to be contaminated. Our definition of “exposed” would also extend to those who were affected due to the evacuation procedures after the disaster (leaving their homes and communities, school, and patients at hospitals within the evacuation areas), regardless of whether they were able to return home or remained displaced four years later.

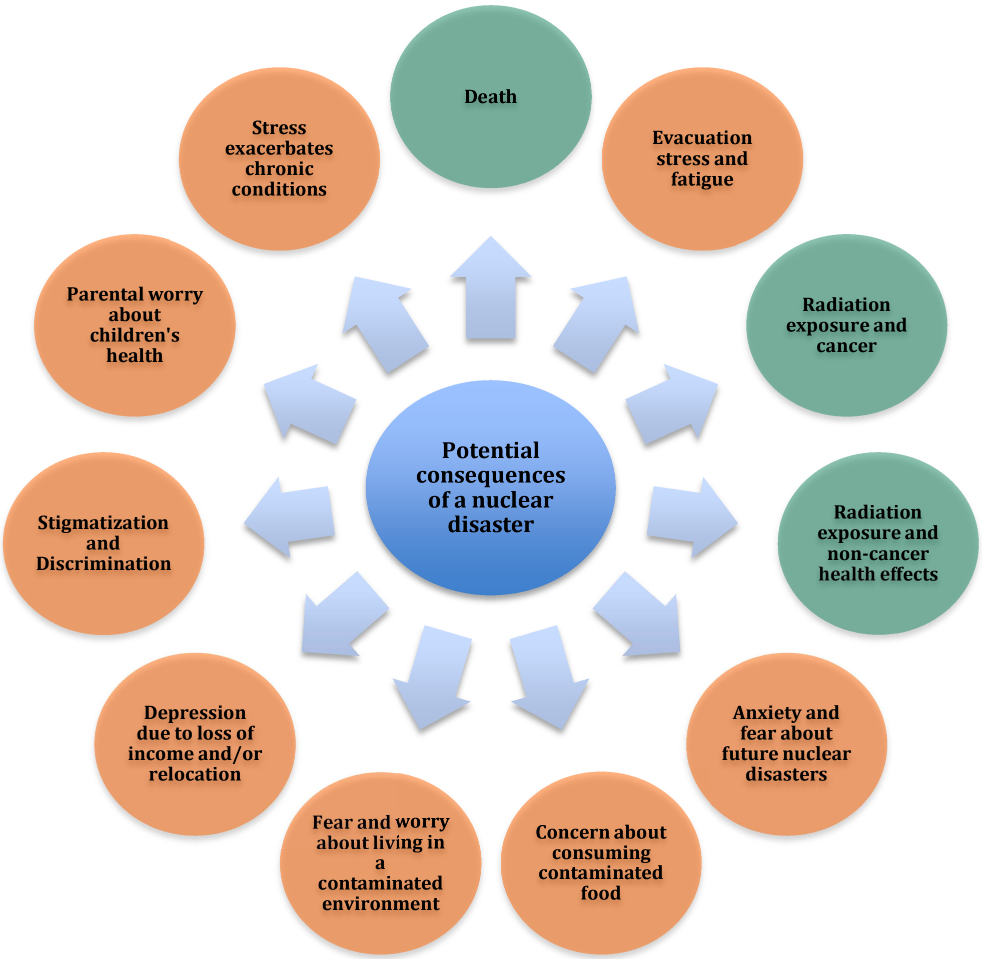
METHODS

For this report, a systematic approach has been adopted to search for information on the number of people affected by the Fukushima Daiichi disaster. In approaching this topic, being affected was construed broadly as described above and included being evacuated because of the radiation release and displaced from a residence, temporarily or permanently. The search engine Google was utilized to run multiple queries that returned results from websites, formal agency reports, and news articles. Table 6 includes a list of the main search queries executed and the number of results they returned. Three search engines were used: Google, Google Scholar, and PubMed. Due to the volume of hits returned from each Google search, the first 60 hits were examined and relevant information was reviewed further if warranted. In addition to the original Google search queries, we sought relevant references within websites visited and various reports and articles. Table 7 lists the reports, articles, websites and books reviewed for this report. Table 8 highlights the number of deaths reported as attributable to the triple disaster, as well as the number of evacuees and health complications as stated in the various sources. Table 9 reports findings from the countries outside of Japan where data were collected on radionuclide levels following the Fukushima Daiichi power plant disaster.

RISKS AND DAMAGES RESULTING FROM THE RADIATION RELEASE FROM THE FUKUSHIMA DAIICHI POWER PLANT

There are multiple potential consequences of nuclear disasters that can affect the population through direct and indirect pathways. The Fukushima accident was preceded by the back-to-back natural disasters of an earthquake and massive tsunami that overwhelmed emergency response systems, even before the reactor problems began. Figure 1 outlines the exposures from a nuclear disaster that can adversely affect people, some involving populations near to the source of radioactive emissions and others at more distant locations. The potential consequences range from death and physical illness to psychological, social, and economic consequences. Some consequences are immediate while others are more remote temporally.

Figure 1: Potential consequences due to nuclear accidents



Green items= direct consequences of the nuclear disaster.
Orange items= indirect consequences of the nuclear disaster.

DEATH TOLL

The majority of deaths attributed to the March 11 disaster resulted from the tsunami and reached a total of about 20,000 people. Lower estimates were reported at around 15, 900 people (14), with over 2,000 people reported missing; while higher estimates reached 23,000 people dead from the twin disasters (15). Overall, estimates in various reports and articles center at about 20,000 dead or missing. The report from UNSCEAR states that the natural disasters of March 11 (i.e., the earthquake and tsunami) claimed the lives of 18,703 people, while 2,674 people were reported missing and 6,220 people were injured as of September 2013 (3).

While no immediate deaths have been attributed to high-level radiation exposure (i.e., due to radiation sickness), the disaster at the Fukushima plant resulted in high-level exposures and unsafe exposures for nearby residents. Consequently, many people were evacuated and substantial numbers are now living as evacuees because of persistently unsafe levels of radiation exposure at their homes. Thus, the stressors to which the surrounding population was exposed included not only radiation exposure, but also the psychosocial stress of being displaced and of facing the possibility of not being able to return home. For those with chronic illness, there were the potential consequences of disruption of basic medical care services. Estimates have been made of the increased mortality associated with such stressors. Several organizations, including the World Nuclear Association, reported estimates for stress-attributable deaths after the disaster as high as 1,916 (16) while the *Japan Daily Press* reported in July 2012 that Japan's Reconstruction Agency estimated that 529 survivors of the disaster had died from the stress of being evacuees (17). A report on a study conducted by the Japan International Cooperation Agency (JICA) for the Japan Reconstruction Agency briefly stated the methodology for these findings as a review of the literature pertaining to the disaster, field visits, and interviews(18). From the news article, we could not determine the source report of the Reconstruction Agency that was cited. Later, another article from the *Japan Times* indicated that according to a Fukushima prefecture report, the deaths due to the nuclear disaster aftermath exceeded those from the twin disasters on March 11th, 2011 at 1,656 and 1,607 dead, respectively(19). An *Asahi Shimbun* news article published in March 2014 claimed that close to 3,000 lives were lost in the aftermath of the nuclear disaster (20); however, the methodology for obtaining the numbers cited, a survey conducted by the same newspaper, was not available for us to review. Two sources briefly report on the process to attain a certification that the cause of death was due to the nuclear power plant disaster (i.e., the stress, fatigue and complications from the evacuation following the radiation release). Based on the sources, an application is completed to have the cause of death assigned as disaster-related(2, 20). The Greenpeace organization reported 573 individuals as having death certificates indicating cause of death as "nuclear-disaster related" along with 29 more deaths pending classification at the time of its report. Based on the report, this statement is listed on a certificate if a death was due to fatigue or a chronic condition aggravated by the disaster (2). The methodology for these estimates could not be confirmed, as the cited source is unavailable.

RADIATION FALLOUT

While much of the radiation released moved over the ocean, emissions of radioactivity did spread over Japan. Figure 2 shows a map of the cumulative deposition of cesium-134 and cesium-137 documenting the distribution of these radioisotopes around the Fukushima Daiichi plants. Figure 3 maps ambient dose rates related to the disaster, showing that the emissions reached to parts of Tokyo, albeit at far lower levels than in Fukushima and nearby locations (21, 22).

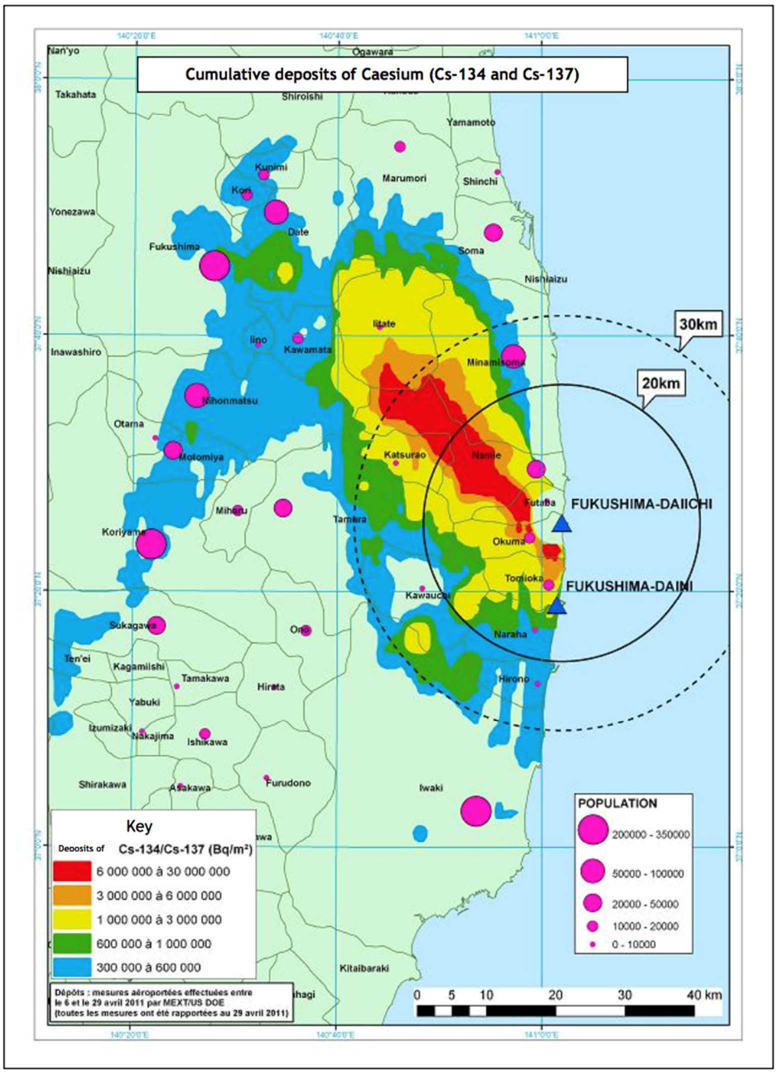


Figure 2: Map of cumulative deposits of cesium-134 and cesium-137 (Bq/m^2). Source: Figure 7 from the Institut De Radioprotection et de Surete Nucleaire (IRSN)- Fukushima Report http://hps.org/documents/IRSN_Fukushima_Report.pdf(21)

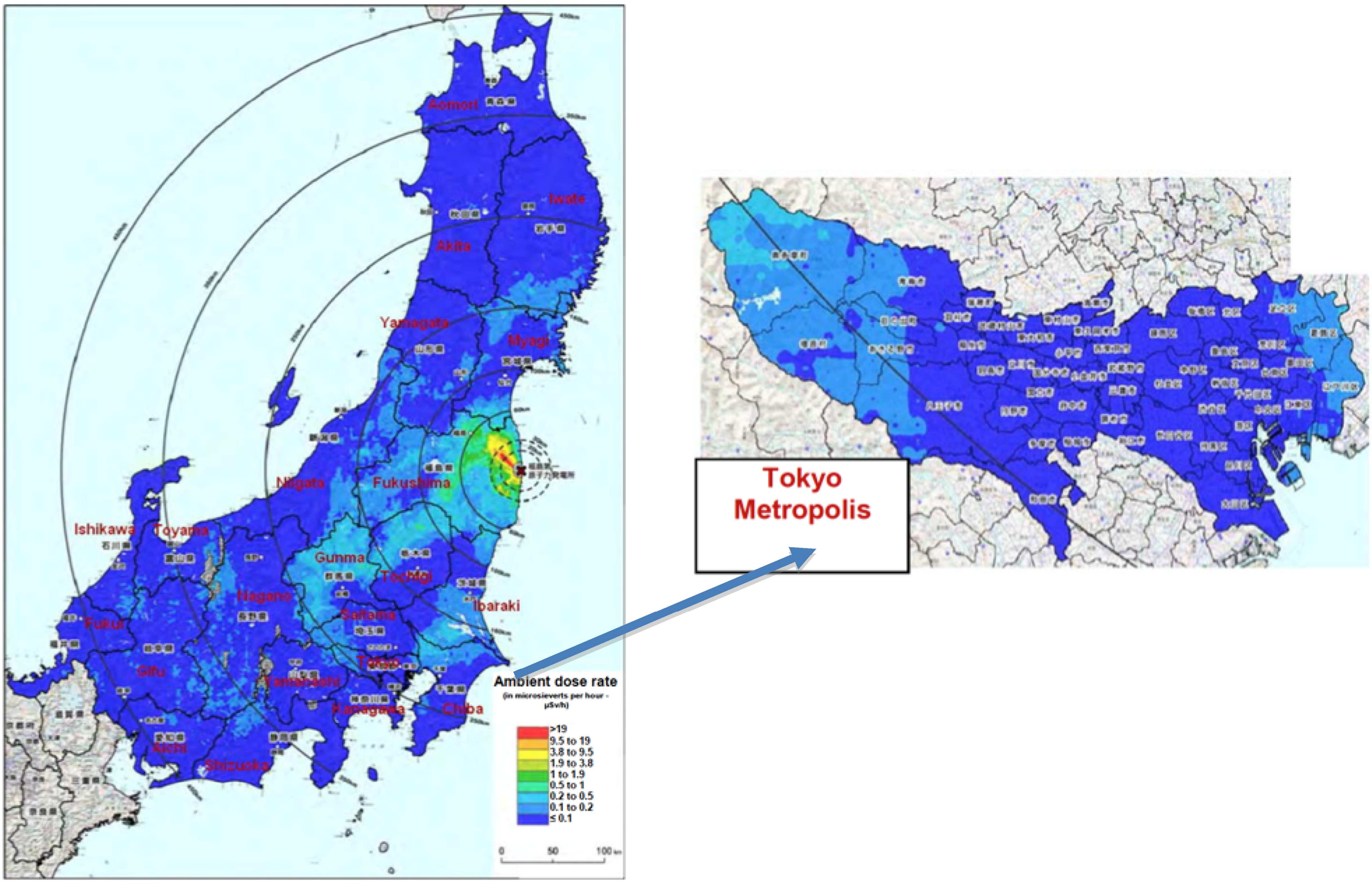


Figure 3: Maps of ambient dose rate at 1 m above ground (µSv/h). Source: IRSN Fukushima: one year later report originally published by MEXT http://www.irsn.fr/EN/publications/technical-publications/Documents/IRSN_Fukushima-1-year-later_2012-003.pdf(22)

Estimates of the population exposed to radiation as a consequence of the disaster can be made based on the measurements and the estimates from dispersion modeling. Of course, there is inherent uncertainty and arguably exposure would have taken place outside of the areas for which doses have been estimated. The available data show that most of the radiation not dispersed over the ocean was deposited over Fukushima Prefecture with lesser amounts deposited across neighboring Prefectures and the rest of Japan. Table 10 summarizes levels of dose based on information gathered from the WHO 2013 report and the UNSCEAR report for the different groups of individuals exposed to radiation from the accident (3, 23). Population estimates for cities and prefectures were obtained from the *Japan Statistical Yearbook 2012* and the numbers reflect the population in 2010 (24). Information for districts, towns and villages was not available from the Statistics Bureau, and in this case, the population estimates reflect numbers found through searches in Wikipedia for each location (25). Some of the data available were from years prior to the accident (2003 and 2008), while others are from 2014. Based on these estimates, we calculated as an upper bound that about 32 million people in Japan were exposed to some additional radiation from the Fukushima accident with the exposure depending on the distance from the site. Most individuals were exposed to radiation doses of 1 mSv or less. There are limitations to this estimate of the number of people exposed. We have assumed that the population estimates for the different districts and towns are unique and are not duplicative; another limitation is that population estimates were obtained from different sources and the numbers from the year 2014 may be different from those prior to the accident. Additionally, we did not include estimates for neighboring countries or the rest of the world as estimates for these locations were below 1 mSv.

In addition to the initial release of radioactive material into the ocean, water leakage at the Fukushima plant continues to be a problem, four years after the accident (26, 27). Reports of pipes breaking and water leaking from containment tanks months and years after the accident are of further concern for the workers and the public. There is concern that radioactive material continues to be released from the crippled power plant, adding to the psychological stress and raising concern as to the safety of seafood, for example levels of radioactivity in tuna and other fish. However, some experts conclude that while there was an increase of radioactive materials in the Pacific Ocean and in sea life, the amount is considered below the levels that would raise concern about consumption by humans (28-30). Researchers from Stony Brook University studied fish from the Fukushima area and found that while most Bluefin tuna fish show levels of cesium below those set by the Japanese government as acceptable, some fish (e.g., bottom fish such as flounders) have been found to have levels above what is considered safe. In Japan the allowable limit for cesium in food is 100 Becquerels per kilogram(31). Flounder caught close to the Fukushima plant had high levels of cesium that exceeded the allowable limit of 100 Becquerels, while Bluefin tuna fish from Fukushima that were caught off the shore of San Diego, California in the United States months after the accident had levels of about 10 Becquerels per kilogram (32, 33).

The Japanese government began to monitor radiation content of foods and limit consumption of foodstuffs that came from areas surrounding the Fukushima Daiichi power plant early in the emergency response process (1). This action limited the intake of iodine-131, thus reducing the potential for high doses to the thyroid that can adversely affect thyroid function and increase thyroid cancer risk. While the Japanese government (e.g., the Ministry of Agriculture, Forestry, and Fisheries and the Ministry of Health, Labour and Welfare) are monitoring and providing results on the safety of food coming from Fukushima, some countries continue to ban exports from Japan (34, 35).

CANCER RISK

Cancer risks have been estimated using standard methods, based on the distribution of radioactivity, the associated doses, and risk models. The World Health Organization (WHO) released a report in 2013, finding that the predicted risk of cancer in areas that were not highly affected by the accident is low (23). The WHO committee reviewing the calculated estimates for effective dose divided those exposed into four main groups, reflecting the levels of radiation dose estimated for the first-year. Doses were not calculated for the area within a 20-km radius of the plant. The most affected group (group 1) resided at two locations within Fukushima Prefecture where effective dose was calculated between 12-25 mSv for the first year. Group 2, comprises areas within Fukushima designated as having an estimated effective dose in the first year between 3-5 mSv. The least affected locations within Fukushima and other areas in Japan (group 3) had a calculated effective dose for the first year of around 1 mSv; and finally, neighboring countries and other parts of the world were estimated to have received a first-year effective dose below 1 mSv. Japan's background radiation dose is 2.4 mSv (1). The locations identified by the WHO for each of the groups are presented in Table 1 below and correspond to information from table 5 of the WHO 2013 report (23).

Table 1: WHO affected groups and locations

Group 1 (12-25 mSv):	Namie Town Iitate Village
Group 2 (3-5 mSv):	Katsurao Village Minami Soma City Naraha Town Kawauchi Village Date City Fukushima City Nihonmatsu City Kawamata Town Hirono Town Koriyama City Tamura City Soma City
Group 3 (1 mSV):	The rest of Fukushima prefecture Neighboring prefectures in Japan
Group 4 (< 1 mSv):	Neighboring countries The rest of the world

The WHO committee estimated lifetime attributable risks (LAR) for leukemia, all solid cancers, breast cancer, and thyroid cancer for males and females of different ages: 1-year olds, 10-year olds and 20-year olds. They also provided the lifetime fractional risk (LFR), which is the ratio of the LAR to the lifetime baseline risk (LBR). By using the ratio, the LAR is scaled to the LBR for the spontaneous cancer rates in the general population of Japan[23, 36]. The LFR represents the "relative increase in cancer risk that could be attributed to radiation exposure"[23]. Below we have compiled findings from the report for leukemias, all solid cancers, female breast cancer, and thyroid cancer for various sex- and age- specific groups based on the WHO panel's calculations. The data in Table 2 and Table 3 show the range of LFRs as a percentage, with the highest LFR for group 1 (the most affected areas) to the lowest LFR for the least affected areas (group 2 for leukemia, all solid cancers, and breast cancer; group 3 for thyroid cancer). The data in these tables is presented in the WHO report in tables 11 and 12 (23). For males, the highest LFR (56%) was for risk of thyroid cancer for infants in the most affected areas (Namie town and Iitate village). Overall, among males, the infant group had the highest LFRs for all locations and all cancer categories compared to children and adults. This was also the case among females for all cancer categories. The LFR percentages for leukemia and thyroid cancer were similar for males and females by age group and by location, for example leukemia LFR in infant boys and girls in the most affected locations was 6.7% and 6.3%, respectively. For all solid cancers, female infants in the most affected area had a higher LFR than male infants in the most affected area, (3.8% compared to 1.8%, respectively); this trend was consistent for all age groups. The LBRs for the different cancers in Japan are low, and therefore the additional LAR from radiation exposure is minimal. For example, the LBR for having leukemia over a lifetime—in Japan (prior to the accident) for male infants (1-year) was calculated to be 0.006 and the LAR—the additional cumulative probability of leukemia over a lifetime—due to radiation exposure was found to be 0.0004; therefore it is estimated that male infants exposed to the radiation from the Fukushima accident had an increased risk for leukemia of 6.7% in the most affected areas. The WHO report concluded that the impact on public health *due to radiation exposure* from the Fukushima disaster is limited(23).

Workers at the Fukushima Daiichi plant (TEPCO employees or contractors) received higher doses of radiation as they worked to bring the crippled plant under control and prepared for shutdown of the reactors. The WHO calculated LARs for male workers who received different levels of exposure and at different ages (groups calculated: 20 years, 40 years, and 60 years) using data released by TEPCO for 23,172 workers (23). The four scenarios assumed by WHO (table 9 in the report) for the calculations were: workers with a total effective dose of 5mSv (group 1); those with a total effective dose of 30mSv (group 2); those with a total effective dose of 200mSv (group 3); and those with a total effective dose of 700mSv (group 4, among whom most of the dose is due to internal exposure from iodine-131).

The assessment for LAR and LFR for male workers was conducted for all solid cancers, thyroid cancer, and leukemia. Data in Table 4 presents the LFR for the age-specific groups based on information from the WHO report in Table 15(23). For workers, the LFR presented in Table 4 show the highest LFR among group 1 and 2, which account for over 99% of the nuclear plant workers and the highest LFR among groups 3 and 4, which make up less than 1% of the workers (with total effective doses between 200 and 700mSv). The LFR was highest for risk of thyroid cancer for all age groups, especially for the less than 1% of workers who were in the youngest group assessed (20 years) at the time of the accident and exposed to total effective doses of 700 mSv.

Table 2: Lifetime fractional risk (LFR) as a percentage based on WHO reported lifetime attributable risk (LAR) and lifetime baseline risk (LBR) for males by age group and location

	Leukemia			All Solid Cancers			Thyroid Cancer		
	Infant	Children	Adult	Infant	Children	Adult	Infant	Children	Adult

Most affected	6.7	3.4	2.6	1.8	1.4	0.97	56.2	25.7	9.0
Least Affected*	1.3	0.7	0.5	0.4	0.3	0.2	14.3	4.3	1.4

LAR used for the most affected areas for all cancer categories= group 1 from WHO report with the highest LAR reported
LAR used for Leukemia and all solid cancers for the least affected areas= group 2 from WHO report with the lowest LAR reported
LAR used for thyroid cancer for the least affected areas= group 3 from WHO report
Infant= 1-year; Children= 10-year; Adult=20-year

Table 3: Lifetime fractional risk (LFR) as a percentage based on WHO reported lifetime attributable risk (LAR) and lifetime baseline risk (LBR) for females by age group and location

	Leukemia			All Solid Cancers			Breast Cancer			Thyroid Cancer		
	Infant	Children	Adult	Infant	Children	Adult	Infant	Children	Adult	Infant	Children	Adult
Most Affected	6.3	3.4	2.3	3.8	3.0	2.0	6.5	4.0	2.3	68.1	31.8	11.6
Least Affected*	1.2	0.7	0.5	0.8	0.6	0.5	1.3	0.8	0.5	17.5	5.1	1.6

LAR used for the most affected areas for all cancer categories= group 1 from WHO report with the highest LAR reported
LAR used for Leukemia and all solid cancers for the least affected areas= group 2 from WHO report with the lowest LAR reported
LAR used for thyroid cancer for the least affected areas= group 3 from WHO report
Infant= 1-year; Children= 10-year; Adult=20-year

Table 4: Highest lifetime fractional risk (LFR) as a percentage based on WHO reported lifetime attributable risk (LAR) and lifetime baseline risk (LBR) for male TEPCO employees and contractors by age and level of radiation exposure

	Leukemia			All Solid Cancers			Thyroid Cancer		
	20 yr	40 yr	60 yr	20 yr	40 yr	60 yr	20 yr	40 yr	60 yr
>99% of workers (group 1 and 2)	2.8	2.3	1.8	1.0	0.6	0.3	20.0	5.8	1.4
< 1% of workers (group 3 and 4)	27.5	22.9	18.2	8.4	4.9	2.4	1694.3	483.2	136.4

LAR used for the >99% of the workers for all cancer categories= scenario 2 from WHO report with the highest LAR reported
LAR used for the <1% of workers for leukemia and all solid cancers= group 3 from WHO report with the highest LAR reported
LAR used for the <1% of workers for thyroid cancer= group 4 from WHO report with the highest LAR reported

Both WHO and UNSCEAR have concluded that future radiation-related health risks due to the Fukushima accident are limited and have provided estimated collective doses in addition to lifetime risks by location, sex and age group. In addition, the UNSCEAR committee calculated and reported collective doses to better estimate the lifetime impact of the release of radioactive material from the Fukushima disaster. Collective doses are reported in man sieverts and are used to understand the total population radiation dose. UNSCEAR calculated collective doses for the first year, 10 years and 80 years following the accident. Below, Table 5 shows the findings from the UNSCEAR report for collective effective dose for 10 years and 80 years. Based on the findings, external exposure is the major pathway for collective effective dose over time while ingestion is the major pathway for the collective absorbed dose to the thyroid. Estimates indicate that the collective effective dose for 10 years including all pathways (inhalation, external exposure, and ingestion) is 36,000 man Sv and at 80 years from the accident it is 48,000 man Sv. For collective absorbed doses to the thyroid, estimates were calculated in man grays (man Gy), were 100,000 man Gy at 10 years and 110,000 man Gy at 80 years(3).

Table 5: Total estimated collective doses due to the Fukushima accident radiation release on March 2011 after 10-years and 80-years from the UNSCEAR 2013 report

	10 years	80 years
Collective Effective Dose (man-Sv)	36,000	48,000
Collective Absorbed Dose to the Thyroid (man-Gy)	100,000	110,000

Estimates of the number of excess cancer cases due to radiation have been made. In a 2011 paper in the *Bulletin of the Atomic Scientists*, von Hippel used calculations from the Chernobyl experience to develop a preliminary estimate of the excess cancer cases due to the Fukushima disaster (37). The author calculated that about one million people lived in areas contaminated with cesium-137 at levels of more than 1 curie per square kilometer. To develop the estimate, von Hippel scaled from the Chernobyl disaster, where 6 million people lived in areas contaminated by cesium-137 at similar levels, resulting in an expected excess of 8,000 cancer deaths. The report made the assumption of one million similarly exposed in Japan, leading to an expectation of about 1000 additional cancer deaths (37). This report was published prior to the calculation of collective doses received by the population.

Two studies calculated the excess number of cancer cases and deaths that could be attributed to radiation exposure from the Fukushima disaster. Ten Hoeve and Jacobson in 2012 published a study on the health effects of the nuclear accident. They modeled emission rates for iodine-131, cesium-134, cesium-137, and barium-137m using data from the U.S. National Data Center and the Zentralanstalt fur Meteorologie und Geodynamik (ZAMG), and exposure pathways including inhalation, ground-level external, and atmospheric external exposures. The dose-response relationship was calculated using the U.S. EPA Dose and Risk Calculation (DCAL) software (38). Findings from the Ten Hoeve and Jacobson study showed that 19% of the cesium-137 deposition was over land, while 81% was over the ocean. The geometric mean was used as the best estimate for the total number of excess morbidity events worldwide due to all pathways of exposure (using extrapolation from the Chernobyl estimates to include ingestion); this figure was calculated at 180 excess morbidities, the range being 24 to 1,800 cases.

For worldwide excess cancer mortality, the authors estimated a range from 15 to 1,100 extra deaths, with the geometric mean being 130 excess mortalities (38). These calculations were performed to understand the health effects over the next 50 years following the disaster. Over 90% of the estimated burden will be in Japan because fallout over land from the Fukushima disaster was mainly deposited in Japan. The authors report that the ranges provided for morbidity and mortality are "derived from uncertainties in the assumed relative risk coefficients and not from uncertainties in emissions or model processes"(38).

In a comment by Beyea et al. on the study conducted by Ten Hoeve and Jacobson, the authors re-calculated the excess cancer cases due to the Fukushima disaster. The investigators estimated that the figure for excess cancer deaths is closer to 1,000, claiming that the previous study did not include "long-term doses from radiocesium in the environment" (39). Beyea et al. used several different estimates of the key parameters to calculate the excess cancer cases. The authors used a longer removal half-life for cesium-137 (2.4 and 38 years) compared to the half-life used in the study by Ten Hoeve and Jacobson (14 days or 0.038 years); the shielding factor was reduced from the 0.85 used by Ten Hoeve and Jacobson to 0.28 (39).

The UNSCEAR committee reported that 160 workers at Fukushima Daiichi were exposed to radiation doses equal to or exceeding 100 mSv and 13 additional workers had high doses of radiation to the thyroid. The average effective dose among these 173 workers is equal to about 140 mSv and it is estimated that about 2 to 3 additional cases of cancer would occur due to radiation exposure (3). Among the 173 workers, no additional cases of leukemia are expected. About 2,000 workers were exposed to thyroid doses exceeding 100mGy (mean dose 400mGy); however the UNSCEAR committee reports, "…any increase in the incidence due to radiation exposure is not expected to be discernible" (3).

Thus, estimates made with standard approaches suggest that any increase in cancer due to the Fukushima accident will be minimal, given that the levels of radiation deposited over land were low and well below those of Chernobyl (1, 3, 23, 40). The worldwide estimates should be viewed as highly uncertain and as a rough indication of the potential global impact.

HEALTH COMPLICATIONS OTHER THAN CANCER

A broad range of outcomes other than cancer is of concern. Over the four years since the disaster, stress, anxiety, depression and other psychological consequences have begun to emerge(41-44). Because of experience gained from the Chernobyl disaster, scientists and doctors are better prepared to document and track quality of life measures as well as other information from those affected by this kind tragedy. The Fukushima Medical University launched a health management survey for those affected by the disaster soon after March 11th. The Fukushima Health Management Survey is intended to document the long-term health and promote well-being of residents affected by the nuclear power plant accident, and to evaluate the long-term exposure to low-dose radiation on the health of the people of Fukushima(12).

Several reports based on data from the Fukushima Health Management Survey have recently been published. A study by Fujimori et al. assessed women who were pregnant during the disaster and found that there were no significant adverse pregnancy outcomes due to the Fukushima accident (45). Data after the disaster showed that the incidence rates of stillbirth (0.25%), pre-term birth (4.4%), low birth weight (8.7%), and congenital abnormalities (2.72%) were similar to those estimated for Japan (45). Another study examining the psychological effects of the disaster utilized data from the Fukushima Health Management Survey for the years 2011 and 2012 for areas designated as evacuation zones in Fukushima Prefecture (target population: n=210,189 for the fiscal year of 2011 with a response rate of 40.7% for adults and 63.4% for children, and n=211,615 for the fiscal year of 2012 with a response rate of 29.7% for adults and 41% for children)(46). This study found that almost 40% of respondents (14,923 participants) in the fiscal year of 2012 responded that they were living away from family members they lived with prior to the nuclear disaster. Results for general mental health were evaluated using the instrument Kessler's K6 (for participants over 15 years old) with a higher score indicating worse mental health status. The mean K6 scores for males and females were 5.5 and 6.8, respectively. In total, 14.6% and 11.9% of respondents scored above the cut-off point of 13 points in the fiscal year of 2011and the fiscal year of 2012, respectively, which is higher than the national average of 3% (46). To assess traumatic symptoms for those 15 years or older, Yabe et al. used the PTSD Checklist Stressor-Specific version scale (PCL-S). Scores of 44 or above indicated having probable PTSD. Findings on the PCL-S showed that 21.6% in the fiscal year of 2011 and 18.3% in the fiscal year of 2012 of respondents had a score of 44 or higher (46). When evaluating children, the authors used the SDQ scale. Findings showed that the percentage of children in the Fukushima evacuation zones with SDQ score of 16 or above was higher compared to the usual scores reported previously for children in communities in Japan (prior to the nuclear accident)—twice as many children in the fiscal year of 2011 and 1.5 times in the fiscal year of 2012(46).

A study by Sakai et al. evaluated differences in hematological parameters for individuals in evacuation areas who were exposed to levels of radiation over 5 mSv compared to those in areas contaminated with lower levels (47). The study utilized data from the Fukushima Health Management Survey and included adults over 20 years old who had completed the Comprehensive Health Check between June 2011 and March 2012 and were residents living in the evacuation zone. Analysis was conducted for individuals stratified by age, gender, and smoking status. The mean counts for white blood cell (WBC), neutrophils, and lymphocytes for residents of 13 locations were compared, and the ratios of those below the standard cut-off levels (<4000/μL, <1600/ μL, and <800/ μL, respectively) were also analyzed among the 13 locations (47). While statistical differences existed when comparing the 13 locations, the authors report that the mean values for the markers were within ±5% of the overall values for the sample and no significant differences existed in the ratios of those under the minimal standard for lymphocyte; therefore concluding that no effects of radiation exposure were found on WBC counts, neutrophils and lymphocytes within 1 year after the Fukushima disaster(47). Another study by Tsubokura et al. compared pre- and post-disaster clinical parameters of individuals in two difference locations, Iitate village and Tamano District, Soma City. Findings from this study, which included 155 participants, indicated that a significant difference existed between the pre and post disaster mean difference [SE] for: BMI (0.64 [0.11], $p<0.0001$), SBP (4.58 [1.28], $p=0.0005$), DBP (2.86 [0.88], $p=0.0014$), glucose level (7.88 [2.13], $p=0.003$), and triglyceride levels (21.33 [7.26], $p=0.0038$)(48). Additionally, the study also collected data on self-reported mental health status and found that 12% of participants had a score of 10 or higher on the PHQ-9, which is considered an indicator for major depression. The PHQ-9 is the Patient Health Questionnaire 9 and assesses mental distress. A score above 10 indicates a moderate to severe degree of depression.

Another study conducted by Yamaki et al. compared the incidence of acute myocardial infarction (AMI) before and after the Fukushima accident(49). Data from the Fukushima Prefecture AMI Registry Survey was analyzed for patients hospitalized between March 11, 2009 and March 10, 2013, and geolocation was recorded for the place of hospitalization, not of the residence. Findings from this study showed that there was no significant difference in the incidence of AMI before the disaster compared to the incidence of AMI after the disaster ($n=38.9$ per 100,000 before the disaster vs. $n=37.9$ per 100,000 after the disaster, $p=0.58$). When the authors compared incidence of AMI before and after the disaster by region within the Fukushima prefecture, they found that there was an increase in incidence of AMI in 2011 compared to 2009 and 2010 in the Iwaki district ($p=0.045$); however, this was not the case for other districts, including Soso, which was the most affected by the triple disaster (49). A study of 90 patients with end-stage renal disease (ESRD) was conducted to examine changes in blood pressure after the triple disaster. Haga et al. evaluated changes in blood pressure for patients at two hospitals, one 40 km away from the Fukushima Daiichi power plant (group considered "exposed"), and the other hospital located 70 km away from the power plant (considered "unexposed"), $n=38$ and $n=52$, respectively (50). Findings from this study showed a statistically significant difference in pre-dialysis SBP and DBP between the exposed and unexposed groups $p=0.001$ and $p=0.008$, respectively. The findings from this study indicate that stress from the disaster may play a role in affecting the short-term physical well-being of ESRD patients.

A group of concern is pregnant women. While the WHO did not find exposure from the Fukushima disaster to increase risk to pregnant women, the worry about radiation exposure may cause maternal distress. A study conducted by Yoshii et al. collected and analyzed qualitative data for 259 women in Miyagi Prefecture who were pregnant during the disaster. Findings indicated that mothers were anxious about the effects of radiation on their babies while *in utero* and once born, about feeding their children contaminated food, staying in Miyagi Prefecture instead of relocating, and exposure at the playground and other places(51).

Stigmatization and discrimination have been documented effects for individuals who are exposed to radiation. For example Chernobyl-affected individuals from our previous focus groups in Bila Tserkva, shared stories on the stigma of being exposed and how this affected their families upon relocation(52). Children were bullied and people were deemed damaged due to radiation exposure, affecting their relationships. One uniquely relevant aspect of the Fukushima nuclear accident is that it took place in Japan, which experienced the atomic bombings during World War II.

In a study of individuals in Hiroshima, Nagasaki, Tokyo and Fukushima, Ben-Ezra et al. from Israel examined the stigmatization and discrimination felt by those exposed to the Fukushima accident (53). The authors explain that the term "Hibakusha", which means exposed individual, has been used for A-bomb survivors and is now being applied to those exposed to radiation from the Fukushima accident. The term has been historically used to stigmatize and discriminate the individuals(53). The study was conducted using online surveys and utilized Geolocation mapping to track participants' locations. The study included 750 participants from Hiroshima/Nagasaki, Tokyo, and Fukushima with similar demographic characteristics. Findings showed that those exposed to the Fukushima disaster felt stigmatized. Results indicated a mean score of 2.0 (SD=1.1) for perception of "Hibaku" for those in Fukushima compared to a mean score of 1.2 (SD=0.6) for the other groups (participants in Hiroshima/Nagasaki and participants in Tokyo) ($p<0.001$). The mean number of PTSD symptoms was also greater for those living in Fukushima compared to those in Hiroshima/Nagasaki and Tokyo ($p<0.001$). Another cross-sectional study of people across Japan was conducted by Ben-Ezra et al. (n=122) and found that grandchildren of the atomic bomb survivors had a higher fear of radiation exposure compared to those who were not descendants of the atomic bomb survivors ($p=0.035$), and also exhibited higher levels of PTSD symptoms compared to the control group ($p=0.007$) (54). Another publication based on the same survey reported that when fear of radiation and fear of another tsunami were added to the model, the relationship between being a grandchild of someone living in Hiroshima/Nagasaki during the atomic bombings and elevated risk of clinical levels of PTSD, which was significant with other factors in the model, became non-significant (OR=2.36, 95% CI: 0.91-6.08, $p=0.076$ and OR=2.47, 95% CI: 0.94-6.44, $p=0.065$, respectively) (55). These studies attest to the psychological consequences of being exposed to radiation. In Japan, the Fukushima disaster has not only left those exposed vulnerable to discrimination and stigmatization from others who see them as damaged or contaminated, but has also contributed to an increase risk of PTSD in those whose families once lived through the atomic bombings.

Another potential consequence of the stress associated with nuclear disasters is suicide. A study published in 2014 assessed the number of suicide attempts by low-mortality methods and high-mortality methods using data from one of the tertiary hospitals where suicide attempts would be referred in the Fukushima prefecture (56). Aoki et al. reported that a total of 154 non-fatal suicide attempts were recorded at the Ohta Nishinouchi tertiary medical center between March 11, 2010 and March 10, 2011, while 112 non-fatal attempts were recorded for the year after the triple accident (March 11, 2011 to March 10, 2012). Standardized incidence ratios were estimated to analyze differences in non-fatal suicide attempts between the groups. Overall, the authors found no statistically significant difference in non-fatal suicide attempts between the control and disaster years after adjusting for age (56). Stratified analysis was conducted for those who attempted suicide with a high-mortality method (e.g., stabbing, hanging, jumping off a great height) and those who attempted suicide with a low-mortality method (e.g., self-poisoning or wrist slitting). The analyses showed that there was a significant increase in the risk for non-fatal suicide attempt with a high-mortality method from March to June 2011 compared to March to June 2010 (56). The study also found no statistical difference was found for risk of non-fatal suicide using a low-mortality method between the two groups.

The mental health of the workers at the Fukushima Daiichi power plant has been documented. In an article published in the *American Journal of Psychiatry*, Shigemura et al. report that the workers of the Fukushima power plant were not only exposed to workplace trauma and overworked, but were discriminated against by the public and had, themselves, lost property and suffered from the evacuation orders (57). Psychiatric visits with the workers revealed PTSD, guilt due to the deaths of coworkers and loved ones, fear of radiation and other mental health consequences. The authors conducted a study of all workers from Fukushima Daiichi and Daini plants (final sample n=885 and n=610, respectively) and collected data between May and June of 2011 (58). Questions included items such as general demographics as well as questions about experiencing discrimination by the public. To evaluate psychological consequences, the authors administered the K6 scale (Japanese version), the Impact of Event Scale-Revised Japanese version (IES-R-J), which included post-traumatic stress response (PTSR) domains(58). The K6 scale is a standardized and validated scale used to evaluate non-specific psychological distress and it has been translated into different languages, including Japanese(59, 60). The IES-R (Japanese version) scale is a 22-item scale for psychological distress caused by traumatic events(61). Findings from the cross-sectional study indicated that both, workers from Fukushima Daiichi and Daini, experienced similar levels of discrimination by the public, for example slurs. A score of 13 points or higher on the K6 scale and 25 points or higher on the IES-R-J indicated high general psychological distress and high post-traumatic stress response. Findings indicate a significant difference in the number of workers who experienced high general psychological distress and high post-traumatic stress responses from the Daiichi plant compared to the Daini plant (412 workers vs. 226 workers, and 261 workers vs. 117 workers, respectively, $p<0.001$)(58).

EVACUEES

Hundreds of thousands of people were evacuated in the days and weeks following the events of March 11th. The devastation from the earthquake and tsunami, followed by the risk of radiation from the damaged Fukushima plant left a total of about 470,000 people as evacuees. Of almost half a million refugees, around 160,000 people were required to evacuate due to the dangers posed by the radiation fallout to the areas within the 20-km radius. These reports vary slightly and low estimates of the number of people evacuated and displaced due to the nuclear plant accident alone are reported by the US National Academy of Sciences and UNSCEAR as 78,000 from within the 20-km radius from the power plant in addition to 62,000 from the 20 to 30-km radius (all of whom at first were asked to stay indoors), and later another 10,000 living to the north-west of the plant who were evacuated when authorities realized that wind direction was moving the fallout in that direction (1, 3). Higher estimates include those reported by the Australian media company, The Age, at 200,000 evacuated within the 20-km radius(62). The final report from the Investigation Committee on the Accident at Fukushima Nuclear Power Stations of Tokyo Electric Power Company included a table of the total number of evacuees by each affected town. In total, 111,760 evacuees were displaced by the time of the July 2012 report, the majority from Namie Town and Minami-Soma City (at over 20,000 evacuees each) (11).

COSTS

The financial costs of a nuclear disaster, such as the Fukushima accident, are difficult to assess. Additionally, the situation in Fukushima is complicated by the three interconnected disasters: the earthquake, the tsunami, and the nuclear disaster. Therefore, economic loss and costs from these interrelated events are difficult to separate. Most reports combine the costs and attempt to calculate the number of lives impacted by the natural disasters (i.e., the earthquake and tsunami) and those impacted by the nuclear power plant accident. Financial costs have been estimated and the figures have changed as more information on the magnitude and long-term effects of the accident are evaluated. The US NAS report on the lessons learned from the Fukushima disaster reported estimates of the economic loss due to the Fukushima nuclear disaster to be over $200 billion US (1). A news article in 2014 reported on a study that found the cost of repairs to be estimated at about $105 billion US. The study was conducted by university professors Kenichi Oshima and Masafumi Yokemoto using data released by TEPCO (63). Others have reported costs from $250 to $500 billion US (64).

EXPOSURE TO RADIOACTIVITY OUTSIDE OF JAPAN

Many studies have been conducted to understand the impact of the Fukushima accident fallout outside of Japan. On March 11th and the days following, the Fukushima Daiichi nuclear power plant was damaged and radioactive material was released into the air. Atmospheric radiation was detected far into North America as well as in parts of Europe and Asia. As noted previously, most of the fallout was deposited into the Pacific Ocean due to the direction of the wind, reducing exposure to humans compared with the Chernobyl disaster in 1986. Studies in 23 countries confirmed elevated levels of radionuclides such as ^{131}I, ^{134}Cs, and ^{137}Cs (some detected other radioactive material as well, such as ^{133}Xe and ^{132}Te among others) days and weeks after the Fukushima disaster. Most studies reported that the levels were very low and did not pose a health risk to humans. Table 9 shows a list of the countries where levels of radioactive material were detected above the normal background levels for the country, after the Fukushima disaster. Additionally, the table indicates the different samples collected and the radionuclides found.

DISCUSSION

The natural disasters that took place on March 11, 2011 not only left thousands dead and displaced, but also crippled the operations of the Fukushima Daiichi plant leading to reactor meltdown. Additional lives were lost due to the nuclear accident and hundreds of thousands of residents from nearby locations were evacuated in an effort to reduce exposure to radiation. Official reports have estimated the risk of cancer from the radiation released to be very low; however, the stress and fatigue from the evacuation and long-term displacement have affected many and will likely have a substantially greater impact on the population than any excess cancer risk due to radiation. Based on population estimates for the locations within Japan that were reported to have been impacted by the fallout from the Fukushima accident at various levels, we estimated an upper bound for those exposed to radiation to be around 32 million people, with most being exposed to levels of 1 mSv or less. A study utilizing data from the Fukushima Health Management Survey for the years 2011 and 2012 found that in 2011, about 15% of respondents 15 years or older from the Fukushima Prefecture showed symptoms of non-specific mental distress when the K6 scale was used as an evaluation tool and about 22% of respondents showed probable symptoms of PTSD as evaluated using the PCL-S scale(46). Extending this percentage to the Fukushima Prefecture population (15 years and older) at the time of the accident (about 1.75 million people according to the *Japan Statistical Yearbook 2012*), we estimate adverse psychological consequences for a range of 263,000 to 385,000 people living within the Fukushima Prefecture at the time of the disaster. From studies on survivors of the Chernobyl disaster, we have learned that psychological consequences and non-cancer effects can last decades after the initial phase of the disaster. To better understand and address the non-cancer health implications of the disaster, the government of Japan has initiated a survey aimed to reach all residents of the Fukushima prefecture, where the nuclear power plant is located.

SUMMARY AND CONCLUSIONS

This review of the literature, comprising various reports and peer-reviewed papers, gives insights into the numbers of people and the various groups affected by the Fukushima disaster. Given the triggering of the nuclear disaster by the earthquake and tsunami, estimates of numbers affected by each of the components are not readily separable and, considering psychological stress, many were tragically affected by both the tsunami and the disaster at Fukushima Daiichi reactor complex. Summarizing the findings of the review:

- Deaths due to the earthquake and tsunami are estimated at around 20,000 people.
- Deaths from the nuclear accident attributed to the stress, fatigue and hardship of living as an evacuee are estimated to be around 1,700 people (reported estimates ranging from about 600 to 3,000 people). Estimates for causes of death of particular interest, e.g., suicide, were not provided.
- The overall evacuation involved over 400,000 people and of these, around 160,000 were evacuated due to radiation from the Fukushima accident.
- Estimates of future cancer risk for Japan are low in relation to background rates. Compared to adults and children, those who were infants at the time of the accident are estimated to have a greater increase in risk for all leukemias, all

solid cancers, female breast cancer and thyroid cancer, as the additional risk from radiation plays out over their lifetimes.

- Two studies attempted to estimate the worldwide excess cancer mortality with results at 130 and 1,000 excess deaths and one estimated 180 excess morbidity cases. The differences in estimates are due to the differing methods and assumptions of the calculations. Of these extra cases, about 90% are expected to be within Japan.
- As with the Chernobyl accident, psychological outcomes and non-cancer outcomes are expected to be major health consequences of the Fukushima disaster.
- Other long-term effects such as stigmatization, discrimination, and fear brought on by radiation exposure are evident early on and expected based on studies from other nuclear disasters.
- Fukushima power plant workers received higher doses of radiation compared to the general public. However, the UNSCEAR report concludes that any increase in cancer risk is not likely to be discernible.
- We estimate an upper bound of about 32 million people in Japan to have been exposed to radiation above background because of the Fukushima accident. The additional exposure depended on distance from the site is 1 mSv or less for most people.
- Extending the percent of people found to have symptoms of probable PTSD and non-specific mental distress due to the disaster to the population 15 years or older within Fukushima Prefecture at the time of the accident, we estimated that about 263,000 to 385,000 people might have been affected with psychological symptoms following the disaster.

In considering the scope of the population affected by the Fukushima Daiichi disaster, several groups are well delineated and their size estimated with reasonable certainty, as listed above: the workers, those displaced by the disaster on the short-term, and those unable to return to their homes because of radiation contamination. A large population is at risk from the psychological stress imposed by the triple disaster. Information is lacking to characterize that population, which most certainly includes those in the environs of the plant and likely beyond. Radiation reached as far as Tokyo and millions were aware that radiation from the disaster had reached them. There was even the possibility that evacuation might become necessary for Tokyo residents.

The aftermath of the manmade nuclear power plant disaster that followed the two natural disasters has clearly led to ongoing stress for those who were evacuated and not able to return home. Many are now in temporary housing and displaced from supportive family and social networks. Lives continue to be affected to this day and the psychological trauma of being displaced, the fear of the invisible radiation looming in the communities, and concern about its effects on those exposed and their children are long-term consequences that may last decades. The water contamination and concern about future radiation leaks at the plant affect the economy in the Tohoku region.

Mistrust of the government and the information disseminated have contributed to a stressful environment. Close to 2,000 people are assumed to have lost their lives in what officials call “disaster-related deaths” due to the fatigue and stress brought on by the evacuation. From research on the Chernobyl disaster, we know that psychological consequences and non-cancer effects continue to affect many almost thirty years after that disaster. Attention needs to be maintained for those affected by the stressors of the Fukushima disaster; assistance needs to be continued for those most affected and monitoring needs to be maintained to understand the full consequences of the disaster.

Table 6: List of Search Queries

Search Engine	Date	Exact Search Query Inputted	Total Results	Results Reviewed
Google	1/6/2015	People exposed to Fukushima nuclear meltdown radiation	359,000	60
Google	1/9/2015	Stress-related deaths from Fukushima	309,000	60
Google Scholar	1/12/2015	Fukushima accident fallout	4,440	100
PubMed	1/13/2015	Fukushima accident fallout	148	148
PubMed	1/15/2015	Bromet [au] AND Fukushima	2	2
PubMed	1/15/2015	Yamawaki [au] AND Fukushima	6	6
PubMed	02/25/2015	Fukushima [title/abstract]; date limit 03/01/2011 to 02/25/2015	1029	1029

Additional search queries for specific studies, websites, or documents included in results from these queries were conducted.

Table 7: List of books, reports, articles and websites visited

Source Type	Organization or Journal	Author	Title or URL
Book		Lochbaum, Lyman, Stranahan, and the Union of Concern Scientists	Fukushima: The Story of a Nuclear Disaster
Documentary	PBS Newshour		Contaminated waters: Fishing for data in the contaminated waters off Fukushima (part 2 or 3)
Journal Article	Arhiv za Higijenu Rada I Toksikologiju	Sostaric, et al.	137Cs in Soil and Fallout Around Zagreb (Croatia) At the Time of the Fukushima Accident
Journal Article	Bulletin of Environmental Contamination and Toxicology	Alonso-Hernandez, et al.	Observations of Fallout From the Fukushima Reactor Accident in Cienfuegos, Cuba
Journal Article	Bulletin of the Atomic Scientists	von Hippel	The Radiological an Psychological Consequences of the Fukushima Daiichi Accident
Journal Article	Disaster Medicine and Public Health Preparedness	Tsubokura et al.	The immediate physical and mental health crisis in residents proximal to the evacuation zone after

			Japan's nuclear disaster: an observational pilot study
Journal Article	Disaster Medicine and Public Health Preparedness	Yamaki, et al.	Impact of the Great Eat Japan Earthquake on Acute Myocardial Infarction in Fukushima Prefecture
Journal Article	Earth and Planetary Science Letters	Huh, et al.	Fukushima-Derived Fission Nuclides Monitored Around Taiwan: Free Tropospheric Versus Boundary Layer Transport
Journal Article	Energy & Environmental Science	Beyea, et al.	Accounting for Long-Term Doses in "Worldwide Health Effects of the Fukushima Daiichi Nuclear Accident"
Journal Article	Energy & Environmental Science	Ten Hoeve and Jacobson	Worldwide Health Effects of the Fukushima Daiichi Nuclear Accident
Journal Article	Environment International	Lozano, et al.	Radioactive Impact of Fukushima Accident on the Iberian Peninsula: Evolution and Plume Previous Pathway
Journal Article	Fukushima Journal of Medical Science	Fujimori, et al.	Pregnancy and Birth Survey After the Great East Japan Earthquake and Fukushima Daiichi Nuclear Power Plant Accident in Fukushima Prefecture
Journal Article	Fukushima Journal of Medical Science	Yabe, et al.	Psychological Distress After the Great East Japan Earthquake and Fukushima Daiichi Nuclear Power Plant Accident: Results of a Mental Health and Lifestyle Survey Through the Fukushima Health Management Survey in FY2011 and FY2012
Journal Article	Global Journal of Health Science	Yoshii et al.	Report on maternal anxiety 16 months after the Great East Japan Earthquake disaster: anxiety over radioactivity
Journal	Health Physics	Bromet	Emotional Consequences of

Article			Nuclear Power Plant Disasters
Journal Article	Isotopes in Environmental and Health Studies	Bihari, et al.	Fission Products From the Damaged Fukushima Reactor Observed in Hungary
Journal Article	JAMA: The Journal of the American Medical Association	Shigemura, et al.	Psychological Distress in Workers at the Fukushima Nuclear Power Plants
Journal Article	Journal of Epidemiology/ Japan Epidemiological Association	Sakai, et al.	White Blood Cell, Neutrophil, and Lymphocyte Counts in Individuals in the Evacuation Zone Designated by the Government After the Fukushima Daiichi Nuclear Power Plant Accident: The Fukushima Health Management Survey
Journal Article	Journal of Hypertension	Haga, et al.	Blood Pressure in Hemodialysis Patients After the Great East Japan Earthquake in Fukushima: The Effect of Tsunami and Nuclear Power Accident
Journal Article	Journal of Psychiatric Research	Ben-Ezra, et al.	From Hiroshima to Fukushima: PTSD Symptoms and Radiation Stigma Across Regions in Japan
Journal Article	Journal of Psychiatric Research	Palgi, et al.	Mental Health and Disaster Related Attitudes Among Japanese After the 2011 Fukushima Nuclear Accident
Journal Article	Journal of Radiological Protection	Hong, et al.	Radioactive Impact in South Korea From the Damaged Nuclear Reactors in Fukushima: Evidence of Long and Short Range Transport
Journal Article	PLos One	Norman, et al.	Observations of Fallout from the Fukushima Reactor Accident in San Francisco Bay Area Rainwater
Journal Article	Proceedings of the National Academy	Madigan et al.	Pacific bluefin tuna transport Fukushima-derived

	of Sciences of the United States of America		radionuclides from Japan to California
Journal Article	Proceedings of the National Academy of Sciences of the United State of America	Smith, et al.	Arrival of the Fukushima radioactivity plume in North American Continental Waters
Journal Article	Psychiatry and Clinical Neurosciences	Kukihara, et al.	Trauma, Depression, and Resilience of Earthquake/Tsunami/Nuclear Disaster Survivors of Hirono
Journal Article	Radiation and Environmental Biophysics	Kellerer, et al.	On the Conversion of Solid Cancer Excess Relative Risk into Lifetime Attributable Risk
Journal Article	Scientific American	Biello	What you should and shouldn't worry about after the Fukushima nuclear meltdowns
Journal Article	Social Psychiatry and Psychiatric Epidemiology	Aoki, et al.	Time-Related Changes in Suicide Attempts After the Nuclear Accident in Fukushima
Journal Article	The American Journal of Psychiatry	Shigemura, et al.	Launch of Mental Health Support to the Fukushima Daiichi Nuclear Power Plant Workers
Journal Article	World Psychiatry: Official Journal of the World Psychiatry Association (WPA)	Ben-Ezra, et al.	Mental Consequences of the 2011 Fukushima Nuclear Accident: Are the Grandchildren of People Living in Hiroshima and Nagasaki During the Drop of the Atomic Bomb More Vulnerable?
Journal Articles	Applied Radiation and Isotopes: Including Data, Instrumentation and Methods For Use in Agriculture, Industry and	Glavic-Cindro, et al.	Detection of Fukushima Plume Within Regular Slovenian Environmental Radioactivity Surveillance

	Medicine		
Journal Articles	Applied Radiation and Isotopes: Including Data, Instrumentation and Methods For Use in Agriculture, Industry and Medicine	Gudelis, et al.	Activity measurement of Gamma-Ray Emitters in Aerosol Filters Exposed in Lithuania, in March-April 2011
Journal Articles	Applied Radiation and Isotopes: Including Data, Instrumentation and Methods For Use in Agriculture, Industry and Medicine	Ha, et al.	Radioactive Contamination Monitoring for the Korean Public Following Fukushima Nuclear Accident
Journal Articles	Applied Radiation and Isotopes: Including Data, Instrumentation and Methods For Use in Agriculture, Industry and Medicine	Lujaniene, et al.	Fukushima Radionuclides in Vilnius/Lithuania Aerosols: Modelling of Aerosol Transport
Journal Articles	Applied Radiation and Isotopes: Including Data, Instrumentation and Methods For Use in Agriculture, Industry and Medicine	Shilian, et al.	Radioxenon Monitoring in Beijing Following the Fukushima Daiichi NPP Accident
Journal Articles	Environmental Science and Pollution Research International	Melgunov, et al.	Fallout Traces of the Fukushima NPP Accident in Southern West Siberia (Novosibirsk, Russia)

Journal Articles	Environmental Science and Pollution Research International	Steinhauser, et al.	Artificial Radioactivity in Environmental Media (air, rainwater, soil, vegetation) in Austria After the Fukushima Nuclear Accident
Journal Articles	Journal of Environmental Radioactivity	Barsanti, et al.	Environmental Radioactivity analysis in Italy Following the Fukushima Dai-ichi Nuclear Accident
Journal Articles	Journal of Environmental Radioactivity	Beresford, et al.	Observations of Fukushima Fallout in Great Britain
Journal Articles	Journal of Environmental Radioactivity	Bolsunovsky, et al.	Evidence of the Radioactive Fallout in the Center of Asia (Russia) Following the Fukushima Nuclear Accident
Journal Articles	Journal of Environmental Radioactivity	Bolsunovsky, et al.	Radioactive Contamination of Pine (Pinus Sylvestris) in Krasnoyarsk (Russia) Following Fallout from the Fukushima Accident
Journal Articles	Journal of Environmental Radioactivity	Carvalho, et al.	Radioactivity from Fukushima Nuclear Accident Detected in Lisbon, Portugal
Journal Articles	Journal of Environmental Radioactivity	Evrard, et al.	Evidence of the Radioactive Fallout in France Due to the Fukushima Nuclear Accident
Journal Articles	Journal of Environmental Radioactivity	Ioannidou, et al.	Fukushima Fallout at Milano, Italy
Journal Articles	Journal of Environmental Radioactivity	Kim, et al.	Radiological Impact in Korea Following the Fukushima Nuclear Accident
Journal Articles	Journal of Environmental Radioactivity	Kritidis, et al.	Radioactive Pollution in Athens, Greece Due to the Fukushima Nuclear Accident
Journal Articles	Journal of Environmental Radioactivity	Leon, et al.	Arrival Time and Magnitude of Airborne Fission Products From the Fukushima, Japan, Reactor Incident as Measured in Seattle, WA, USA

Journal Articles	Journal of Environmental Radioactivity	Long, et al.	Atmospheric Radionuclides From the Fukushima Dai-ichi Nuclear Reactor Accident Observed in Vietnam
Journal Articles	Journal of Environmental Radioactivity	MacMullin, et al.	Measurement of Airborne Fission Products in Chapel Hill, NC, USA from the Fukushima Dai-ichi Reactor Accident
Journal Articles	Journal of Environmental Radioactivity	Manolopoulou, et al.	Radioiodine and Radiocesium in Thessaloniki, Northern Greece Due to the Fukushima Nuclear Accident
Journal Articles	Journal of Environmental Radioactivity	Paatero, et al.	Airborne Fission Products in the High Arctic After the Fukushima Nuclear Accident
Journal Articles	Journal of Environmental Radioactivity	Perrot, et al.	Evidence of 131I and (134, 137)Cs Activities in Bordeaux, France Due to the Fukushima Nuclear Accident
Journal Articles	Journal of Environmental Radioactivity	Pham, et al.	Detection of Fukushima Daiichi Nuclear Power Plant Accident Radioactive Traces in Monaco
Journal Articles	Journal of Environmental Radioactivity	Pinero Garcia, et al.	Traces of Fission Products in Southeast Spain After the Fukushima Nuclear Accident
Journal Articles	Journal of Environmental Radioactivity	Pittauerova, et al.	Fukushima Fallout In Northwest German Environmental Media
Journal Articles	Journal of Environmental Radioactivity	Povinec, et al.	Aerosol Radioactivity Record in Bratislava/Slovakia Following the Fukushima Accident—A Comparison With Global Fallout and the Chernobyl Accident
Journal Articles	Nature	Brumfiel	Fukushima’s Doses Tallied
Journal Articles	Nature	Brumfiel	Fukushima: Fallout of Fear
Journal Articles	Nature	Harmon	Japan’s Post-Fukushima Earthquake Health Woes Go Beyond Radiation Effects

Journal Articles	Scientific American	Dahl	Fukushima Meltdown Unlikely to Lead to Large Numbers of Cancers
Journal Articles	Scientific American	Fecht	1 Year Later: a Fukushima Nuclear Disaster Timeline
News Article	Bloomberg Businessweek	Gale	Fukushima Radiation May Cause 1,300 Cancer Deaths, Study Finds
News Article	Bloomberg View	Gale	Fukushima Radiation Proves Less Deadly Than Feared
News Article	Huffington Post	Kageyama	As Fears of Fukushima's Radiation Linger, Children Flee Homes for Distant Schools
News Article	International Business Times	Justice	Fukushima: contaminated water leak still a 'challenging issue'
News Article	News on Japan	Jiji Press	42 Months on, Over 240,000 Still Living as Evacuees
News Article	RT		Fukushima Disaster Bill More than $105bn, Double Earlier Estimate- Study
News Article	RT		Radiation level in tuna off Oregon coast tripled after Fukushima disaster
News Article	The Age	Watson	Japan's Radiation Disaster Toll: None Dead, None Sick
News Article	The Guardian	McCurry	Fukushima Radiation Levels 18 Times Higher Than Previously Thought
News Article	The Washington Post	Harlan and Nakamura	Japanese Nuclear Plant's Evaluators Cast Aside Threat of Tsunami
News Article	Time Magazine	Sifferlin	Fukushima Three Years Later: How One Town is Coping
News Articles	EcoWatch	Pantsios	Thyroid Cancer in Young People Surge in Fukushima Since Nuclear Meltdown
News Articles	EcoWatch	Pawlyszyn	Was I exposed to Radiation from Fukushima?
News Articles	Japan Daily Press	Hofilena	Japanese Government,

			TEPCO Being Sued for Fukushima Stress Related Deaths
News Articles	Japan Daily Press	Westlake	Evacuees Dying After Over a Year of Fatigue and Despair
News Articles	The Asahi Shimbun	Fujiwara	Three Years Later: Stress-Related Deaths Reach 2,973 in Tohoku
News Articles	The Japan Times		Fukushima's Appalling Death Toll
News Articles	The Japan Times	Kyodo	Fukushima Stress Deaths Top 3/11 Toll
Presentation		Yasumura	Overview of Fukushima Health Management Survey
Presentation	Ministry of Agriculture, Forestry and Fisheries (Japan)		Response to radionuclide contamination in foods after the nuclear power plant accident
Report	Greenpeace International		Lessons from Fukushima
Report	Greenpeace International		Fukushima Fallout: Nuclear Business Makes People Pay and Suffer
Report	Institut de Radioprotection et de Surete Nucleaire (IRSN)		Assessment on the 66th Day of the Projected External Doses for Populations Living in the North-West Fallout Zone of the Fukushima Nuclear Accident: Outcome of Population Evacuation Measures
Report	Institut de Radioprotection et de Surete Nucleaire (IRSN)		Fukushima, One Year Later: Initial Analyses of the Accident and its Consequences
Report	Institute of Nuclear Power Operations (INPO)		Lessons Learned from the Nuclear Accident at the Fukushima Daiichi Nuclear Power Station
Report	Investigation Committee on the Accident at		Interim Report

	Fukushima Power Stations of Tokyo Electric Power Company		
Report	Investigation Committee on the Accident at Fukushima Power Stations of Tokyo Electric Power Company		Final Report
Report	Japan International Cooperation Agency (JICA)		The Study of Reconstruction Processes from Large-Scale Disasters- JICA's Support for Reconstruction- FINAL REPORT
Report	National Academy of Sciences		Lessons Learned from the Fukushima Nuclear Accident for Improving Safety of US Nuclear Plants
Report	National Academy of Sciences		The Science of Responding to a Nuclear Reactor Accident: Summary of a Symposium
Report	Psychological Medicine	Kessler	Short screening scales to monitor population prevalences and trends in non-specific psychological distress
Report	Statistics Bureau		Japan Statistical Yearbook 2012
Report	United Nationals Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)		Sources, Effects and Risks of Ionizing Radiation: United Nationals Scientific Committee on the Effects of Atomic Radiation 2013 Report- Annex A: Levels and Effects of Radiation Exposure Due to the Nuclear Accident After the 2011 Great East-Japan Earthquake and Tsunami
Report	World Health		Health Risk Assessment from

	Organization (WHO)		the Nuclear Accident After the 2011 Great East Japan Earthquake and Tsunami, Based on a Preliminary Dose Estimation
Reports	National Police Agency of Japan		Damage Situation and Police Countermeasures Associated with 2011 Tohoku District-off the Pacific Ocean Earthquake
Reports	National Police Agency of Japan		Special Report I: Police Activities and the Great East Japan Earthquake
Reports/Web site	Japan's Reconstruction Agency		Towards Reconstruction "Hope Beyond the Disaster"
Reports/Web site	Japan's Reconstruction Agency		Reconstruction Promotion Committee FY2012 Report on Discussions
Reports/Web site	Japan's Reconstruction Agency		Towards the Creation of "New Tohoku" (the Interim compilation of Discussions)
Reports/Web site	Japan's Reconstruction Agency		The Process and Prospects For Reconstruction
Reports/Web site	Japan's Reconstruction Agency		http://www.reconstruction.go.jp/english/
Website	Center for Marine and Environmental Radiation		http://ourradioactiveocean.org
Website	Centers for Disease Control and Prevention		http://www.cdc.gov
Website	Fukushima on the Globe		http://fukushimaontheglobe.com/
Website	Ministry of Agriculture, Forestry and Fisheries		http://www.maff.go.jp/e/quake/press_110312-1.html
Website	Ministry of Health Labour and Welfare (Japan)		http://www.mhlw.go.jp/english/topics/2011eq/index_food.html

Website	Physicians for Social Responsibility		http://www.psr.org/
Website	US Department of Veterans Affairs		http://www.ptsd.va.gov
Website	Wikimedia		https://www.wikipedia.org/
Website	Woods Hole Oceanographic Institution		http://www.whoi.edu
Website	World Nuclear Association		http://www.world-nuclear.org

Table 8: Reported deaths, injuries, and evacuations due to the triple accident on March 11, 2011

Source	Year	Deaths/Missing people due to earthquake and tsunami	Injuries due to earthquake and tsunami	Deaths after the disaster *	Evacuated/Displaced	Suspected/Confirmed Cancer or other health problems
Fukushima on the Globe Website(65)					160,000	
Nature(66)						140,000 people close to plant have low risk of cancer. 167 workers exposed to higher radiation doses are at slightly higher risk of developing cancer.
Physicians for Social Responsibility(64)					159,128 from exclusion zones	
Investigation Committee on the Accident at Fukushima Nuclear Power Stations of TEPCO(10)	2011				>110,000 still evacuated as of report	
The Japan Reconstruction Agency(67)	2011	23,000 dead or missing				
The Washington Post(15)	2011	23,000				
Bloomberg Businessweek(68)	2012					Best estimate of cancer cases is 180

Source	Year	Deaths/Missing people due to earthquake and tsunami	Injuries due to earthquake and tsunami	Deaths after the disaster *	Evacuated/Displaced	Suspected/Confirmed Cancer or other health problems
						(range 24-2,500); Best estimate of cancer deaths globally 130 (range 15-1,300).
Greenpeace(2)	2012	20,000		573 certified. 29 cases pending.	448,000 refugees in shelters.	
Institute of Nuclear Power Operations (INPO)(69)	2012	1,000			>140,000 from Fukushima pref.	
Investigation Committee on the Accident at Fukushima Nuclear Power Stations of TEPCO(11)	2012				111,760	
Japan Daily Press(17)	2012			529		
Nature(70)	2012	> 15,850			At least 340,000	
BloombergView(71)	2013	20,000			>300,000 left homeless	
Greenpeace(72)	2013				160,000 forced evacuation and tens of thousands voluntarily left Fukushima pref.	
Japan Daily Press(41)	2013			Over 100		1,539 suffering from stress related to the nuclear disaster
JICA Study(18)	2013				About 400,000 total; 150,000 from Fukushima due to nuclear plant disaster	
Nature(73)	2013	20,000			156,000	Mental health of 210,000 people in jeopardy.
The Age(62)	2013	20,000		1,000	200,000 evacuated within 20-km radius	
The Guardian(74)	2013	19,000			160,000 evacuated due to nuclear power	

Source	Year	Deaths/Missing people due to earthquake and tsunami	Injuries due to earthquake and tsunami	Deaths after the disaster *	Evacuated/Displaced	Suspected/Confirmed Cancer or other health problems
					plant	
The Japan Reconstruction Agency(75)	2013	18,000 dead or missing			As high as 470,000	
The Japan Reconstruction Agency(76)	2013				310,000 to date	
UNSCEAR Report(3)	2013	18,703 deaths; 2,674 missing	6,220		150,000	
EcoWatch(77)	2014					89 confirmed cases of thyroid cancer in children
EcoWatch(78)	2014					104 of 300,000 children examined were diagnosed or suspected of having thyroid cancer
National Academy of Science Report(1)	2014	15,900 deaths; 2,600 missing			150,000 (includes 78,000 from within 20-km radius, 62,000 20-30km radius, and 10,000 from the north-west area from plant.	
National Police Agency of Japan(79)	2014	15,467 deaths; 7,482 missing as of June 2011				
News on Japan(80)	2014	15,889 deaths; 2,601 missing.			246,000 living as evacuees to date	
Scientific American(81)	2014				160,000	
The 3rd International Expert Symposium in Fukushima (September 8-9, 2014)	2014	1,603 deaths; 204 missing (as of September 1, 2014)		1,753	164,845 due to FNPP accident in Fukushima pref.	
The Asahi Shimbun(20)	2014			2,973 in Fukushima, Iwate, and Miyagi		
The Huffington	2014					33 children diagnosed

Source	Year	Deaths/Missing people due to earthquake and tsunami	Injuries due to earthquake and tsunami	Deaths after the disaster *	Evacuated/Displaced	Suspected/Confirmed Cancer or other health problems
Post(82)						with thyroid cancer. 1 in 4 children affected by disaster suffer from depression, anxiety, and other mental problems.
The Japan Reconstruction Agency(83)	2014				470,000 (in 2011)	
The Japan Times(19)	2014	1,607 in Fukushima prefecture		1,656 from Fukushima pref., 434 from Iwate pref., and 879 from Miyagi pref.		
The Japan Times(13)	2014			1,656 Fukushima pref., 434 Iwate pref., and 879 Miyagi pref.		
Time Magazine(43)	2014					In Hirono town: more than half of 241 participants had clinical symptoms of PTSD and two-thirds reported having depression symptoms.
World Nuclear Association (84)	2014				160,000	
World Nuclear Association (16)	2014			1,916		
National Police Agency of Japan(14)	2015	15,889 deaths; 2,594 missing to date	6,152 to date			

* Deaths due to stress and fatigue of evacuation process. To date, no deaths have been reported due to direct radiation

Source	Year	Deaths/Missing people due to earthquake and tsunami	Injuries due to earthquake and tsunami	Deaths after the disaster *	Evacuated/Displaced	Suspected/Confirmed Cancer or other health problems
exposure (e.g., from radiation sickness)						

Table 9: Impact of Fallout from Fukushima Daiichi power plant accident outside of Japan

Radiation outside of Japan Detected	Methods
Cienfuegos, Cuba(85)	Fallout samples collected. Evidence of fission products ^{131}I and ^{137}Cs found, but at very low levels that pose no risk to the health of the public.
Italy(86, 87)	Atmospheric particulates and deposition, seawater, mussels and sheep milk. Evidence of ^{131}I, ^{134}Cs and ^{137}Cs at different sites. No concern to public health
42 sites in Great Britain(88)	Collected grass samples, rainwater, and some foodstuffs including sheep milk. ^{131}I and ^{134}Cs were detected.
Hungary(89)	Collected aerosol samples, dry/wet fallout samples. ^{131}I, ^{134}Cs and ^{137}Cs were detected, but not in levels that pose a risk to public health.
Russia(90-92)	Environmental samples collected. ^{131}I, ^{134}Cs and ^{137}Cs detected.
Greece(90, 93, 94)	Environmental samples, sheep milk airborne particulate matter and grass and soil samples were collected. ^{131}I, ^{134}Cs and ^{137}Cs detected in different samples.
Lisbon, Portugal(95)	Aerosol and atmospheric surface deposition analyzed. ^{131}I, ^{134}Cs, ^{137}Cs and ^{132}Te levels low and pose no risk to public health.
France(96, 97)	Environmental samples, grass and soil samples. Evidence of ^{131}I, ^{134}Cs and ^{137}Cs in different samples.
Slovenia(98)	Rain water, aerosol and iodine filters analyzed. ^{131}I, ^{134}Cs and ^{137}Cs were detected.
Lithuania(99, 100)	Aerosol samples collected. ^{131}I, ^{134}Cs, ^{137}Cs and ^{129m}Te levels detected.
Korea(101-103)	Personal monitoring of more than 800 members of the Korean public. Levels of external and internal contamination were found to be within screening levels. ^{134}Cs and ^{137}Cs found in wet and dry deposition samples.
Taiwan(104)	^{131}I, ^{134}Cs and ^{137}Cs detected at different times.
USA(6, 7, 105)	Airborne fission products ^{131}I, ^{132}I, ^{132}Te, ^{134}Cs, and ^{137}Cs were detected.
Vietnam(106)	^{131}I, ^{134}Cs and ^{137}Cs were detected in surface air stations throughout Vietnam.
Huelva province, Iberian Peninsula(107)	^{131}I, ^{132}I, ^{132}Te, ^{134}Cs and ^{137}Cs detected in the trajectory of air masses.
Norway(108)	Aerosol samples collected. ^{131}I, ^{134}Cs and ^{137}Cs were detected.
Principality of Monaco(109)	Air monitoring showed that ^{131}I, ^{134}Cs and ^{137}Cs were detected, but were not of concern to public health.
Spain(110)	Aerosols, rainwater, vegetables and cheese were analyzed. ^{131}I, ^{134}Cs and ^{137}Cs were detected in different samples.
Germany(111)	Rain water, river sediment, soil, grass and cow milk were analyzed. ^{131}I, ^{134}Cs and ^{137}Cs were detected in different samples.
Slovakia(112)	^{131}I and ^{137}Cs were detected as well as ^{7}Be.
People's Republic of China(113)	^{133}Xe and ^{131m}Xe detected.
Croatia(114)	^{137}Cs detected in soil and fallout samples.
Austria(115)	Air particulate, rainwater, grass, and soil samples were analyzed. Low levels of ^{131}I and ^{137}Cs were detected, but there was no concern to public health.

^{131}I=iodine-131; ^{132}I= iodine-132; ^{132}Te= tellurium-132; ^{134}Cs=cesium-134; ^{137}Cs=cesium-137; ^{133}Xe= xenon-13; ^{131m}Xe=xenon-133m

Table 10: Estimated number of people exposed to radiation from the Fukushima Daiichi nuclear accident

Estimated level	Group of people	Exposed to the Fukushima disaster/ year of data estimate (if different from 2010)
12-25 mSv	Iitate Village [b]	5,909 (12/2014)
	Namie Town [b]	18,386 (12/2014)
3-5 mSv	Date City [a]	66,081
	Fukushima City [a]	292,280
	Hirono Town [b]	5,005 (12/2014)
	Katsurao Village [b]	1,451 (12/2014)
	Kawamata Town [b]	14,287 (12/2014)
	Kawauchi Village [b]	2,552 (12/2014)
	Koriyama City [a]	338,772
	Minami Soma City [a]	70,895
	Naraha Town [b]	7,098 (12/2014)
	Nihonmatsu City [a]	59,866
	Soma City [a]	37,796
	Tamura City [a]	40,434
1 mSv	Aizuwakamatsu City [a]	126,125
	Iwaki City [a]	342,198
	Shirakawa City [a]	64,710

	Sukagawa City [a]	79,279
	Kitakata City [a]	52,373
	Motomiya City [a]	31,501
	Yama District [b]	31,175 (2008)
	Tamura District [b]	30,658 (2003)
	Onuma District [b]	29,787 (2008)
	Nishishirakawa District [b]	68,450 (2003)
	Minamiaizu District [b]	33,533 (2003)
	Kawanuma District [b]	36,117 (2003)
	Iwase District [b]	31,847 (2003)
	Ishikawa District [b]	48,399 (2003)
	Higashishirakawa District [b]	38,087 (2003)
	Adachi District [b]	8,577 (12/2014)
	Koori town [b]	12,096 (12/2014)
	Kunimi town [b]	9,484 (12/2014)
	Futaba town [b]	6,113 (12/2014)
	Okuma town [b]	11,515 (2010)
	Tomioka town [b]	15,839 (12/2014)
	Shinchi town [b]	7,722 (12/2014)
	Chiba Prefecture [a c]	6,217,000
	Gunma Prefecture [a c]	2,008,000

	Ibaraki Prefecture [a c]	2,969,000
	Miyagi Prefecture [a c]	2,348,000
	Tochigi Prefecture [a c]	2,007,000
	Iwate Prefecture [a]	1,331,000
	Tokyo [a]	13,162,000
<100 mSv	TEPCO workers [d]	24,659
> 100 mSv	TEPCO workers [d]	173
Estimated Total Exposed (in Japan)		32,143,299

[a] Source: The Japan Statistical Yearbook for 2012
[b] Source: Wikipedia website https://www.wikipedia.org
[c] List of neighboring prefectures from table 6 of the WHO 2013 report
[d] Source: UNSCEAR 2013 report

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